

A new Californian liverwort.

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WITH PLATE II.

In March of last year the writer received from San Diego a liverwort, which on examination seemed to differ very much from any described form, and was therefore subjected to a somewhat careful study. An investigation of the structure of the plant showed such marked peculiarities that it could not be satisfactorily referred to any described genus, and therefore it seemed necessary that a new genus should be established to contain it. For this the name *Geothallus* is proposed.

The plants were growing in company with *Ophioglossum nudicaule*, and were collected by Mrs. Brandege, to whom I am also indebted for additional specimens which made it possible to determine the most important points of structure, and the systematic position of the plant.

When the specimens of *Ophioglossum* were received, they were not examined immediately, but the clods of earth upon which they were growing were watered, and placed under bell-jars, where they were left undisturbed for a week or more. When they were examined, at the end of this time, my attention was at once drawn to a number of bright green, palmately lobed little plants which had not been noticed when the specimens were first received. They were evidently thallose liverworts of some kind whose growth had been stimulated by the moisture under the bell-jar. A careful examination of Schiffner's *Hepaticæ*¹ failed to throw any light upon the systematic position of the plant, and specimens were then sent to Dr. L. M. Underwood, who reported that it was a form quite new to him. There were no sporogonia found in the first lot of specimens, but later these were obtained when it was evident that the plant belonged to the group of anacrogynous *Jungermanniaceæ* to which Goebel² gives the name *Anelatereæ*, owing to the absence of perfect elaters. As at present but a single genus belonging to this group, *Sphæro-*

¹Engler and Prantl, *Die natürlichen Pflanzenfamilien* 90, 91.

²Goebel, *Die Muscineen*. Schenk's *Handbuch der Botanik* 2: 363.

carpus, is known from the United States, and this genus is in some respects the most primitive of all known Hepaticæ, the discovery of an allied genus is of more than ordinary interest as perhaps throwing some light on the affinities of the lower Hepaticæ.

The thallus, as first observed, consisted of a cylindrical basal portion, expanding forward into a number of spreading irregular lobes, so that the whole was somewhat fan-shaped (Fig. 4). Further examination showed that this fan-shaped thallus was really a secondary growth from the primary thallus which was more or less buried in the earth (whence the name "Geothallus"). At the time they were received, the plants had apparently about completed the season's growth and were beginning to dry up; and as they had lost much of their original green color and were partially buried in the ground, were quite overlooked.

The older thallus is more or less wedge-shaped, but often nearly orbicular in outline, about 5–7^{mm} in length by 3–4^{mm} in breadth (figs. 1–3). It is usually simple, but occasionally once dichotomous (fig. 3). The body of the thallus is thick and fleshy, passing quite abruptly into the margin, or wings, which consist of more or less regularly lobed laminæ composed for the most part of a single layer of cells. These marginal laminæ are sometimes arranged quite regularly, so that they recall the similar leaf-like laminæ of *Fossombronia*; indeed in some cases the general aspect of the plant is not unlike the common Californian *Fossombronia longiseta*. In addition to these marginal lobes, there are numerous dorsal laminar outgrowths, which may almost completely conceal the dorsal surface of the thallus (fig. 2, *a.*), and give it a very characteristic appearance. The plant is attached to the ground by numerous colorless rhizoids, and from the ventral surface, especially near the apex, are jointed, glandular hairs, which curve over the growing-point, and are like those characteristic of most of the thallose Jungermanniaceæ.

If the old plants are given plenty of moisture, growth is resumed, and the apex of the thallus rapidly grows out into the fresh green shoot first observed. The marginal lobes of these secondary growths are narrower and longer than in normally developed specimens, due, no doubt, to the excess of moisture where they were grown.

The specimens were too old for a satisfactory study of the

sexual organs, and these were not produced in a normal manner upon the secondary shoots. Enough was seen, however, to show that in a general way both archegonia and antheridia are similar to those of *Sphaerocarpus*. The archegonium (fig. 7), however, is larger, and the neck somewhat longer and straighter, and it is not so distinctly stalked. The antheridium is much the same shape as that of *Sphaerocarpus*, but the early divisions are apparently less regular. A very marked difference between the genera is the much greater number of the sexual organs in *Sphaerocarpus*, where they completely cover the dorsal surface of the thallus. In *Geothallus* they are produced much more sparingly, and there is, apparently, no difference in the form and size of the male and female plants, whereas this is very noticeable in *Sphaerocarpus*. Indeed it is not impossible that *Geothallus* may sometimes be monoecious. As in *Sphaerocarpus* the sexual organs are surrounded individually by a sac-shaped envelope, which is relatively much less developed than there.

The sporogonium resembles closely that of *Sphaerocarpus terrestris*, but is larger. The fully grown sporogonium is a nearly spherical capsule about 1^{mm} in diameter, connected by a very short seta to the bulbous foot which is sunk in the thallus. Owing to the nearly sessile position of the archegonium, the foot is not raised above the level of the thallus as is the case in *Sphaerocarpus*. The sporogonium wall is composed of a single layer of rather thick walled cells, which at maturity are almost black in color. The capsule is filled with a mass of spores intermingled with thin-walled oval cells like those found in *Sphaerocarpus* (fig. 8, c.). These sterile cells which here are probably only nutritive in function, are doubtless the homologues of the elaters of the more specialized *Hepaticæ*. They are oval cells, measuring from 48—108 μ in length, and as a rule are relatively longer than the similar cells of *Sphaerocarpus*. They contain some chlorophyll, and scattered granules, apparently of albuminous nature, but little or no starch, while in *Sphaerocarpus* there are numerous large starch granules present.

The spores are very large, and at maturity separate completely. They are nearly globular and range from 120—140 μ in diameter. The wall is very thick, and in section (fig. 6, b.) shows two well marked layers, perinium (epispore), and exospore. An endospore is also probably present, but in micro-

tome sections is not clearly differentiated from the inner layers of the exospore. The perinium appears perfectly homogeneous, and is smooth except upon the ventral surface of the spore where it is folded so as to produce reticulated ridges which in section have the appearance of spines (fig. 8, *b*, *c*). The character of the spore-contents was not especially studied beyond noting the fact that the nucleus is quite small, as is usually the case in the spores of liverworts.

The most peculiar feature of the plant, and one which appears to be unique among *Hepaticæ*, is the formation of tubers by means of which it becomes perennial. These tubers were always met with in the older individuals, and in the secondary shoots from the older thallus were also developed after a short time. The tuber consists of an oval mass of cells derived from the interior tissue of the thallus, and including its growing-point. These cells are densely filled with coarsely granular contents, mostly made up of albuminous granules and oil-drops, very little starch being present. The first indication of the formation of the tuber is an accumulation of granular matter in the interior cells of the thallus just back of the apex, and this extends in all directions until it includes nearly the whole central region of the thallus, as well as the cells of the growing point. The chlorophyll disappears from the cells and sections of the ripe tuber appear white and opaque. Surrounding the central tissue is a more or less clearly defined dark cortex, which does not, however, extend over the cells of the growing point. The whole tuber is surrounded by a loose brownish envelope composed of the dead outer cells of the thallus. The full grown tuber is a flattened body from 1–2^{mm} in length and about half as wide.

The tubers are obviously a special provision for carrying the plant through the long dry season. Specimens kept perfectly dry from May until about the first of October, germinated promptly when placed in water for a few days. Growth begins by the cells near the growing point turning green and the latter resuming its activity. The development of the young plants from the tubers has not yet been studied in detail, but it is hoped soon that it may be possible to follow out completely the life-history of this interesting form.

There seems no doubt that the affinities of *Geothallus* are with the lower *Jungermanniaceæ*, the *Anelatereæ*. As already stated it agrees with *Sphaerocarpus* in the general

characters of the sexual organs and sporogonium, but the very different structure of the thallus, the similarity of the male and female plants, and especially the formation of the tubers, make it impossible to unite it with that genus.

GEOTHALLUS, nov. gen. — Plant thalloid, simple or dichotomous by branched, thallus fleshy, wedge-shaped or nearly orbicular, partially buried in the earth; margin of thallus divided into irregular leaf-like lobes, similar laminae upon the dorsal surface; ventral surface with numerous simple, colorless rhizoids and jointed glandular hairs near the apex; sexual organs scattered over the dorsal surface, each surrounded by a sac-shaped envelope: sporogonium globular, with very short seta and bulbous foot; capsule-wall composed of a single layer of black cells; spores very large, mingled with thin-walled sterile cells; plant perennial by means of tubers developed at the end of the growing season.

G. tuberosus, nov. sp. — Plant dioecious, male and female alike: spores black, smooth except upon the ventral surface where there are reticulate ridges, $120-140\mu$ in diameter; sterile cells $48-108\mu$ in length.

Sandy soil near San Diego, California, growing with *Ophioglossum nudicaule*. Collected by Mrs. Katherine Brandegee, March, April, 1895.

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EXPLANATION OF PLATE II.

Geothallus tuberosus Campbell.

Figs. 1, 2. Two old plants; *a*, seen from above; *b*, from the side; $\times 4$.

Fig. 3. A large specimen showing dichotomy; $\times 4$.

Fig. 4. Secondary shoot from a specimen which had been grown under a bell-jar; $\times 10$.

Fig. 5. Median section of a fruiting thallus, showing *sp*, a sporogonium, *t*, the young tuber; $\times 10$.

Fig. 6. *a*, microtome section of a ripe sporogonium, $\times 30$. *b*, microtome section of a ripe spore, $\times 150$. *c*, transverse section of the reticulated ridges upon the ventral surface of the spore, $\times 300$.

Fig. 7. An old archegonium, seen in optical section, $\times 100$.

Fig. 8. *a*, tetrad of nearly full-grown spores, $\times 150$. *b*, two ripe spores, $\times 150$. *c*, three sterile cells, $\times 150$.